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Mr. BRIDGES's

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REASONS

FOR BUILDING

A BRIDGE

OF

THREE ARCHES

ON THE

OLD FOUNDATIONS:

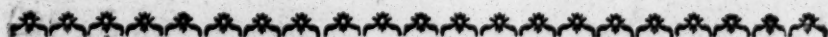
WITH HIS

OBJECTIONS

TO

The *Single Arch* Plan,

Of 116 Feet Chord, and 32 Feet high.



B R I S T O L:

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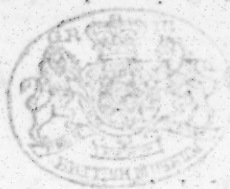
1762

Eng. Hist. Topog. vol 15.

M. BRIDGE
R. A. S. O. D. S.

A. BRIDGE

THREE ANGLES



C. B. O. I. O. S.

The M. S. S.

OF THE

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Mr. BRIDGES's
REASONS, &c.



*To the COMMISSIONERS appointed by
Act of Parliament, for Rebuilding
BRISTOL BRIDGE.*

GENTLEMEN,

HERE having been great Pains
TAKEN, and Reasons urged, to ren-
der Redcliff and the Chapel Piers
entirely useless; and as no Advo-
cate hath appeared in Defence of them,
You are pleased to lay your Commands
on me, to give my Reasons why I think
them sufficiently strong to support a Bridge
of Three Arches.

In Order to deal candidly with my Op-
ponents, I shall give their Objections their
full Weight, and answer them with the

greatest Candour and Impartiality, for the better Government of your Choice in a Plan.

First Objection,—*The Old Foundations are not sufficiently strong to support a New Bridge thereon, particularly the Chapel Pier ; because it is built without Bond, without Cement, with Stones of various Sizes, laid in various Positions, which does not reach the Rock ; and that the New Pier would stand Part on the Casing, and Part on the Core, which may subject the Foundation to a Settlement.*

Answer,—As the Solidity and Goodness of the Redcliff Quay Wall, and St. Nicholas Pier, was never doubted, it will be needless to say any Thing about them. I shall therefore give you a Description of the Redcliff and Chapel Piers only.

The Redcliff Pier is 57 Feet in Length, and 27 in Breadth, built with a Casing of 2 Feet 6 Inches thick, well bonded and cemented ; the Inside (which by some is called the Core) is built with Masonry, laid Bonding, with large Materials, though not the best cemented, yet *as well settled and bonded as the outside Casing, consequently not liable to any new Settlement.*

The Chapel Pier is 82 Feet in Length and 34 in Breadth, built with a Casing of 2 Feet

Feet 8 Inches thick, remarkably well bonded and cemented. The Inside is built with *some* large Materials, nay there are several Stones which exceed Half a Ton Weight, and so judiciously placed, as to bond and tye the smaller Work together. The Quantity of Sand indeed was too great, in Proportion to the Lime that was used in building the Inside of this Pier, which has, in Part, eaten out the Lime; *but then it must be acknowledged, that this Work is also as well SETTLED and BEDDED as the outside Casing; consequently not liable to any new Settlement.*

The Redcliff Pier (at the Depth of 7 Feet 6 Inches from Low Water Level) is seated on a good Gravel 2 Feet 6 Inches thick, a strong White and Red Sand 4 Feet thick, a hard stiff Clay 2 Feet thick, under which lies the Solid Rock. In the whole 16 Feet.

The Chapel Pier (at the Depth of 10 Feet from Low Water Level) is seated on a good Gravel 3 Feet 6 Inches thick, a strong White and Red Sand 2 Feet 6 Inches thick, a hard Stiff Clay 2 Feet thick, under which lies the Solid Rock. In the whole 18 Feet.

Having given you a succinct Account of the Dimensions and Constructions of these two Piers, and of the several Stratas under them, I shall now beg Leave to ask of any *unprejudiced* Man of Judgment and Experience

rience, if he would erect a Pier, with its two adjoining Half Arches, * on a Basis so *extensive*, so *solid*, and so well *settled*, as these Old Foundations are ?

Or,

* Which Pier and Half Arches should press no greater Weight than One Ton and Three Quarters upon every superficial Foot of the Foundation, from the Plinth to the Under-side of the Cornice; that being the True Weight of such Piers, viz.

The EXACT WEIGHT of Stone in one Pier, and its two adjoining Half Arches, impressed on every Superficial Foot of the Redcliff Pier, from the Level of the Under-Side of the Cornice, supposing the same to be built Solid with Courtfield Stone.—An Article absolutely necessary to be known, to shew how little liable the Old Foundations are to a Settlement, with the new-intended Weight placed thereon.

First, Of the Lower Plinth of the Pier, viz. Mean Length 48 Feet, Breadth 12 Feet, and Height 2 Feet; Solidity 1152 Cube Feet.

Secondly, Of the Shaft of the Pier from the Plinth to the Springing of the Two Half Arches, viz. Mean Length 44 Feet, Breadth 10 Feet, and Height 4 Feet; Solidity 1760 Cube Feet.

If the Quantity of Stone in the Lower Plinth, viz. 1152 Cube Feet be added to 1760 Cube Feet in the Shaft of the Pier, the Total 2912 Cube Feet is the Quantity of Stone in the Plinth and Pier, up to the Springing of the Two Half Arches.

Thirdly, The Two Arches and the Upper Part of the Peir between them.

As the Diameters of the Two adjoining Arches to the Pier are the one 52, the other 40 Feet, therefore the Height of the Less is 20, and of the Greater 26. I will suppose the Crown of the Two Arches only 3 Feet each: Now 3 Feet in Height added to 20, the Radius of the lesser Arch makes it 23; and 3 Feet added to 26, the Radius of the greater Arch makes it 29; and therefore if 23 be added to 29, the Sum is 52 Feet, whose Half is 26, which is th

Mean

Or, would he erect the same Building on a good Gravel 3 Feet 6 Inches thick?

Or,

Mean Height at the Middle of the Pier above the Springing of the Two Arches, which is one Dimension. Again to 20 the Radius of the lesser Arch, add 10 Feet the Diameter of the Pier, and 26 Feet the Radius of the greater Arch, and then the Sum 56 is another Dimension, whose Product is 1456 Feet, which is the Area of the Two Half Arches with their Spandrels, and of the Pier contained between them.

Now from 1456 Feet, the aforesaid Area, be subtracted 845 Feet, the Area of the Two Quadrants in the Voids of the Two Arches, the Remains 611 Feet will be the Area of the Two Spandrels of the said Two Half Arches, and of the Upper Part of the Pier contained between them.

Supposing the Two said Spandrels to be worked up entirely Solid with Stone, then the aforesaid Area of 611, being multiplied by 42 Feet, the admitted Breadth of the Bridge, the Product 25,662 is the Number of Cube Feet contained in the said Two Half Arches, and their inclosed Pier, above the Springing of the Arches; the Salient Parts of the Pier, before the Uprights of the Bridge, only excepted; whose Solidities, as a Right Angle Triangle, are 392 Cube Feet more.

Now, If to 2,912 Cube Feet, the aforesaid Quantity contained in the Pier below the Springing of the Arches, be added 25,662 Cube Feet, the Quantity of the Pier above the Springing of the Arches, and the two Half Arches on its Sides, and 392 Cube Feet the Quantity contained in the Two Salient Angles of the Pier, the Total 28,966 is the Quantity of Cube Feet of Stone, in the Pier and the Two Half Arches, up to the Level of the Under Side of the Cornice aforesaid, which is equal to 1810 Tons, allowing every 16 Cube Feet of Stone to be a Ton Weight.

Now the *Redcliff* Pier is 27 Feet wide, and 40 Mean Length, contains 1,080 Superficial Feet; therefore if 28,966 Cube Feet, be divided by 1,080 the Number of Superficial Feet, contained on the Surface of that Pillar, on which the New Pier is supposed to be placed, the Quotient is no more than $28 \frac{726}{1080}$, which is the exact Number of Cube

Or, on a strong Red and White Sand 2 Feet 6 Inches thick ?

Or, on a hard stiff Clay 2 Feet thick ?

Or, on a Solid Rock of an immense Thickness ?

To these several Questions he will naturally answer YES, and rejoice he has been so fortunate as to meet with such a secure and permanent Foundation as either of them.†

Surely

Cube Feet of Stone, impressed on each Superficial Foot of that Foundation, which is no more than One Ton and Three Quarters, the Fraction excepted, from the Level of the Under Side of the Cornice aforesaid ; a Weight quite inconsiderable, in Comparison to the Weight it has been compressed with for upwards of 500 Years ; especially as the New Arches will press in the same perpendicular Manner as the Old Ones did, and not in any New Direction, which must in my Opinion, take off all Objection to the making Use of the Old Foundations.

† “ The Cathedral of St. Paul, which is certainly the
 “ finest, as well as the most ponderous Fabrick in England,
 “ stands upon a Layer of Clay or Pot Earth, about 6 Feet
 “ thick on the North Side, and hardly 4 Feet on the South
 “ Side, and nothing under it but dry Sand, mixed some-
 “ times unequally, but loose, so that it would run through
 “ the Fingers for above 40 Feet in Depth.”—For a further
 Account see Parentalia & Memoirs of the Family of the
 Wren's, Page 285, &c.

“ Westminster Abbey stands upon a Close Small Sand,
 “ and nothing of a firmer Consistence is to be found under
 “ neath to the Depth of several Feet.

“ Part of Greenwich Hospital, viz. The uppermost Pa-
 “ vilion

Surely then, if the Old Piers, or either of these Stratas, be sufficient to bear the Weight of such a Superstructure, how much more secure must it be when they happen all together, with a Rock at the Bottom, as in the present Case? *More especially as they have been compressed, with a Weight greatly superior to that intended to be placed thereon, for upwards of 500 Years?*

The sinking Pier of *Westminster* Bridge was loaded ~~with~~ Cannon and Pig Iron, ~~to~~ *with* a greater Weight than it was to support after the Arches should be turned a second Time; and it remained there six Months, in Order that the Pier might settle so much, as not to risque a second Settlement, after the Arches should be so turned, which has ever since stood firm and well: *How much more Reason then is there to believe, That the Foundation of Bristol Bridge, which has undergone a similar Trial for such a vast Number of Years, should hereafter settle with an inferior Weight, equally placed on a Basis so extensive and solid, with such excellent Stratas underneath?*

B

The

“ vilion stands firm and well upon a Thin Stratum or Layer
“ of Gravel, under which is a Quicksand.

“ The new Treasury stands extremely firm, though its
“ Foundations are laid upon a thin Layer of Gravel about
“ 6 Inches thick, and under which is a very bad Ground,
“ and even a Quicksand in many Places.”—See Mr. LAB-
BELYE'S Description of *Westminster* Bridge.

The 52 and 56 Feet Arches in *Westminster* Bridge, have only a Stone Basis 16 Feet wide ; whereas the 52 and 40 Feet Arches in *Bristol* Bridge may have a Stone Basis 27 Feet wide : *Here is a much less Weight, intended to be placed on a much greater Basis.*

If these Old Piers would support the Center, on which the greatest Part of the incumbent Weight of a Single Arch must bear, before it can possibly be relieved by keying in, *I should imagine them sufficiently strong to support an Inferior Weight, which will be more equally distributed.*

In widening of *London* Bridge, the Builders have erected the new Work on the *Old Sterlings*, yet they are capable of supporting the additional Piers and Arches, without causing the least perceptible Crack or Settlement : *How much more capable then is our Old Foundations to support a Building less lofty and less weighty ? Especially as the Latter have been built on before, and the Former never were.*

In *York* Bridge (which formerly consisted of Seven narrow Gothic Arches built upon *Sterlings*) the Three Middle Arches were taken away, and a Flat Segment Arch of 82 Feet 6 Inches Span erected in their Places, without any Addition

tion to the Old Foundations; which stand firm and well, altho' the Arch presses in a New Direction. *In short I have not the least Reason to doubt the Sufficiency of the Old Foundations. I could mention a greater Number of similar Cases; but as these are so very plain and obvious it will be needless.*

Second Objection.—*From the Manner Mr. Bridges designs the coping of the Old Piers, it is necessary to observe in that Case, that the Old Foundations will be weakened and nearly lost; besides this Coping must have all the fatal Effects of so many sunken Rocks, for the Craft of the River to strike continually upon, in passing through the Bridge.*

Answer,—The Redcliff Pier is already taken down to the Depth of 3 Feet under Low Water Mark, by the Advice of Mr. Phillips and your express Order, and there yet remain 4 Feet 6 Inches of Solid Masonry: And after the Chapel Pier is so taken down, there will remain more than 7 Feet. Now, compare this Depth to the deepest laid Foundation in Westminster Bridge, and you will find them nearly equal; Westminster being short of 6 Feet, (out of which must be taken the Thickness of the grating, viz. 1 Foot 8 Inches)*
B 2
and

* See Mr. LABELYE's Description of Westminster Bridge, Page 35.

and 'some not more than 4 Feet: And so far are they from being weakened thereby, that they will be made much ~~the~~ stronger; for if any one will but consider the Manner proposed for Bonding and Tying the Old and New Work together, by the Coping, he will see, if not *prejudiced*, that they will be made more secure and permanent than they ever were; and the Coping of no Obstruction to the Navigation, even at the lowest State of the Tide, as may be better seen and understood by viewing it drawn at large in the *Guild-hall*, than by any Description I can give here. Besides, when the New Bridge comes to take Place, the Current will flow more gently thro' such wide Arches, than it did thro' the Narrow Ones of the Old Bridge; and therefore the River in those Places will rather fill up, than wear and grind, as it did when the Old Bridge was standing, *consequently the Old Foundations in Time will be more and more buried.*

Third Objection.—*A Bridge of Three Arches built on the Rock 18 Feet to the Eastward of the Old Bridge, on the Redcliff Side (only), will be a better Situation for the intended New Bridge, than if placed on the Old Foundation, as the Current will run more at right Angles with the Piers.*

Answer.

Answer.—Undoubtedly all Bridges placed at Right Angles with the Stream are best ; but the Risque attending the Navigation on Passing the Old Bridge, was more owing to the Narrowness of the Arches, than to the trifling Obliquity of the Stream, which Inconveniency must naturally vanish as soon as the intended New Bridge is finished, the Navigable Arch being no less than 52 Feet Diameter, whereas the largest in the Old Bridge did not exceed 26 Feet 9 Inches. *The great and many Advantages attending this single Improvement, is scarcely to be conceived at first Thought, and must take off all Objection to the imperceptible Obliquity of the Stream.* Besides, a Bridge so situated, would not only increase the Angle at the Entrance of the Bridge from *High-street*, and cause a very awkward Passage, but it would place the East Side of that Bridge in a Direction so wide to the East Side of *St. Thomas-street*, as must make it absolutely necessary to purchase the Houses on that Side also.

Nay, was a Bridge of Three Arches to be built 18 Feet up the Stream, and seated on the Rock, the Downfall of the Temporary Bridge would be almost certain, as the Salient Angles of the two present Piers on the *Redcliff* Side do not exceed 21 Feet 7 Inches asunder, and the Depth down to the
Rock

Rock 16 Feet, and close behind the *Redcliff* Quay Wall 19 Feet 6 Inches, from Low Water Level. Besides, the great Expence, Time, and Difficulty, that would attend such an Undertaking, in a River so Narrow and Rapid, and block'd up with such large Piers with such small Spaces between them, must unavoidably tear and destroy the whole Bed of the River from one Side to the other, quite down to the Rock, *and perhaps meet with Difficulties unsurmountable.*

When the Well was sinking behind the *Redcliff* Quay Wall, as soon as we came to the Gravel, the Water made into the Well much faster than at any Time before; I tasted the Water, and found it tolerably good. When these Circumstances appeared, I looked on them as the Prefages of a Natural *Spring*. Mr. *Hall*, Mr. *Hellicar*, and Mr. *Thrall*, have each a Well at the Distance of about 50 Yards from hence, near the same Level, and never known to be dry. There is also another, sunk but a few Years ago by Mr. *Bencraft*, close behind the St. *Nicholas* Abutment, known to be a remarkable fine Spring, and not the least brackish: To the Truth of this last Particular, both him and his Servant Girl made an Affidavit at the Sale of his House.

It may not be unreasonable to suppose, that when the Builders of *Bristol Bridge* were about to lay the Foundations thereof, they intended to seat it on the Rock, but finding the Springs too powerful, they placed it on the Gravel.

I am also of an Opinion that the Ground from one Side of the River to the other is springy, and if this should prove a *Fact*, so many Piles that may be drove to form the Inclosure, so many Springs will certainly arise. And if the Water should ouze or flow into the Inclosure, in greater Quantities than can be emptied in the Space of one Hour or thereabouts, it will be impossible ever to see the Rock in any reasonable Time, as the Ebbing and Flowing of the Tide, twice in 24 Hours, must be taken into the Account.

It may not be amiss to give you the Sentiments of the ingenious Mr. Labelye on a similar Case. Mr. Labelye's Adversaries did not approve of his laying the Foundation of Westminster Bridge in a Caissoon, but earnestly advised and pressed the Use of the Cofferdam, such as are called by the French Batterdeaux. Mr. Labelye, in his Description of Westminster Bridge, Page 49, 50, 51, and 52, makes the following Reply.

“ As

“ As it may happen that some Readers
 “ may not know what is meant by Coffers-
 “ dams, or Batterdeaux, I beg Leave to ex-
 “ plain it in a few Words.

“ In the Building of Piers of Bridges,
 “ Sluices, or other Works in Water, Engi-
 “ neers or Architects, have often Recourse
 “ to this Method, viz. To inclose the Place
 “ intended for the Foundation, so as to keep
 “ the Ambient Water from coming in, that
 “ it may be drained dry, and kept so by
 “ Pumping or other Engines. Sometimes
 “ this Enclosure is single, and sometimes
 “ double, with Clay rammed between;
 “ sometimes the Enclosures are made with
 “ Piles, only driven close by one another;
 “ sometimes those Pieces are notched or
 “ dove-tailed one into another; sometimes
 “ the Piles are groved, and driven at a Dis-
 “ tance, and Boards let down between
 “ them: But let the Inclosure or Inclosures,
 “ be made in any of the Ways mentioned,
 “ or in any other Way, the sole Intent is
 “ only to keep the Water from coming into
 “ the Foundation, whenever it can be drain-
 “ ed. The first Inconveniency attending
 “ this Method, is, that if the Inclosure be
 “ not strong enough, or not sufficiently
 “ propp’d or brac’d in the Inside, it will not
 “ be able to support the Pressure of the
 “ External Water, which by breaking
 “ and

“ and bursting in, often destroys many
 “ Lives, and entirely defeats the Intentions
 “ of the Projectors, that have not taken the
 “ necessary Precautions; of which I could
 “ give a great many Instances, some of
 “ which I have been an Eye-Witness to.
 “ But if this Method had no other Incon-
 “ veniency, it could easily be remedied in
 “ the Execution of the intended Bridge,
 “ *England*, and *London* especially, abound-
 “ ing with excellent Artificers of all Kinds.
 “ But what would have rendered it entirely
 “ useless or ineffectual, is the Nature of the
 “ Ground under the River *Thames*, which at
 “ the Place where the Bridge is, is every
 “ where a Gravel, covered over on the *Sur-*
 “ *ry* Side with a Sort of Loomy Sand, all
 “ which would suffer the Water to ouze up,
 “ (notwithstanding the Side of the Batter-
 “ deaux or Cofferdams should be perfectly
 “ tight) so fast, especially the *Gravel*, as to
 “ put it out of the Power of any Engine or
 “ Engines, to drain the Batterdeaux or Cof-
 “ ferdam. Indeed where the Ground under
 “ the Foundation is a stiff Clay, or an Earth
 “ of a sufficient Consistency to hold Water,
 “ Batterdeaux or Cofferdams have been used
 “ with Success, tho’ attended with an im-
 “ mense Expence and Trouble, and what I
 “ would have made Use of, if I had not
 “ foreseen that it would have been in vain
 “ to attempt in this Place to come at the
 C “ Bottom

“ Bottom, and much more to reach several
 “ Feet under the Bed of the River by any
 “ such Means. Those that have seen, or
 “ have been concern’d in Buildings in Water,
 “ where the Ground is a *Gravel*, or a loose *Clay*
 “ or a Sand, well know the inseparable
 “ Difficulties that would have arisen if such
 “ Cofferdams or Batterdeaux had been at-
 “ tempted on the *Thames* over-against the
 “ Woolstaple; where, besides the Agitation
 “ of the Water, occasion’d by the Winds,
 “ the Height of the Water is perpetually in-
 “ creasing or decreasing from 6 Feet to about
 “ 23 Feet perpendicular Height above the
 “ Surface of the Bed; which two Circum-
 “ stances alone would make it difficult, and
 “ very expensive, to provide proper Mate-
 “ rials, and construct a Cofferdam sufficiently
 “ strong to resist such unequal Pressures so
 “ as to keep out the ambient Water. As to
 “ the Ouzing in of the Water through the
 “ Pores and Interstices of the Gravel, loose
 “ Clay, or Sand, it may easily be shewn,
 “ that if all the Interstices in the Bottom of
 “ the Foundation of one of the Piers, taken
 “ together, amount only to a Hole of 6 Inch-
 “ es square (which is a Supposition much
 “ under the Truth) and supposing the Tide
 “ or Height of the Water above the Foun-
 “ dation (as it is at a Mean or at an Aver-
 “ age between the highest and lowest)
 “ about 15 Feet perpendicular, they would
 “ give

“ give above 770 Tons per Hour, which is
 “ more than 70 Men could pump out, even
 “ supposing them to act always with the
 “ same Strength as they do at first, and to
 “ work Day and Night without ceasing, and
 “ more than 150 Men, or 30 Horses, could
 “ do, working as they commonly do.”

“ All that I shall add to this Article is,
 “ that some of the Persons who proposed or
 “ espoused this Method of making an Inclo-
 “ sure round the intended Pier with Dove-
 “ tail'd Piles, and pretended to drain the
 “ Water from within, may remember how
 “ fruitless was the Attempt, or rather Ex-
 “ periment, that was made in *Hyde-Park*
 “ not many Years ago.”

The Truth of what Mr. LABELYE has advanced on this Subject, I believe, will not be doubted; and as there is every where a *Gravel* underneath the Old Foundations (which, as I have before observed, is *springy*, and at so *great a Depth*) I'm of Opinion, that to attempt Inclosures of this Sort at *Bristol Bridge* would be attended with more and greater Difficulties than in the *Tbames*, not only from the *Springs* and the *great Depth*, but from the *Narrowness of the River*, the *Rapidity of the Current*, the *Magnitude of the Inclosures*, and the great Obstruction to the *Navigation*, besides guard-

ing against every supposed Fatality in a Situation so singular and hazardous.

Upon the whole I cannot think it advisable to attempt new Foundations, especially as the old ones have been prov'd to be altogether SUFFICIENT by a large Number of HONEST, ABLE, and EXPERIENCED MEN. And Mr. PHILLIPS hath asserted, * that a Bridge of Three Arches, on the *Old Piers*, would be as useful as one built on *New Foundations*.

Since the last Meeting I have bestowed most of my Thoughts and Time on the Single Arch Plan propos'd that Day, which then appear'd to me as the most eligible one; † but on duly weighing and well considering every Requisite, I am of Opinion it is liable to several weighty Objections; therefore, in Duty to the *Public*, and in JUSTICE to *myself*, I shall endeavour to explain them in the best and shortest Manner I can.

OBJECTIONS

* See Mr. PHILLIPS's Report.

† As I never saw the Plan before that Meeting, which I then made on the Face of an old Drawing, I was not qualified to answer a Question so unexpectedly put to me with that Precision the Nature of it required; yet I cannot but think if the two Piers are taken out of the River, it will make the Single Arch preferable to any other Plan, *that is*, so far as may relate or appertain to the singular Advantage. —I do not mean as preferable when every Requisite shall be duly weighed and considered, as the following Objection, in my Opinion, will greatly outweigh the Advantage.

OBJECTIONS to the Single Arch Plan proposed at the last Meeting.

First Objection. As this Single Arch Bridge will contract the Water-way more than is generally believed, I shall first draw a Parallel between it and that of Three Semi-circular Arches, viz.

<i>Single Arch.</i>	<i>Feet.</i>	<i>Three Arches.</i>	<i>Feet.</i>
At Low Water	116	At Low Water	132
First Quarter Flood	106	First Quarter Flood	132
Half Flood.	96	Half Flood	122
Three Quarters Flood	82	Three Quarters Flood	106
High Water	64	High Water	77
	<hr/> 464		<hr/> 569
			464
			<hr/>
		Difference in Favour of Three Arches	} 105

This Arch of 116 Feet Chord is intended to spring between St. *Nicholas* and the Chapel Piers at the North End, and between the *Redcliff* Pier and the *Redcliff* Quay Wall at the South End. This will be placing it so much on one Side of the River as to make it quite offensive to the Eye, and will appear to every Stranger as if plac'd there by Mistake.—*On the other Hand*, The Bridge of Three Arches will extend itself across the River 152 Feet, which will make it the most beautiful Object of any Three Arch Bridge in *England*, and by far the widest in Proportion to its Length, it being 42 Feet in Breadth

Breadth, and but 172 in Length ; whereas *Westminster* Bridge is no more than 44 Feet broad, tho' the Length is 1220.

Second Objection. The Breadth between *St. Nicholas* New Quay Wall and the *Red-cliff* Old Quay Wall is 202 Feet. At the mean Height between high and low Water the single Arch is 96 Feet Chord, consequently the 202 Feet Breadth of Water, from one Key Wall to the other, will be suddenly forc'd through a Breadth of 96 Feet. *On the other Hand*, the Three Arches at the same mean Height is 122 Feet in Breadth. This makes an Increase of Water-way in Favour of the Three Arches at the mean Height 26 Feet, and if it be calculated upon the whole Flow of the Tide the Difference will be 105 Feet, (and in the Three Elliptical Arches much more.) Besides this singular Advantage, the Current, instead of being hurl'd together, will be properly divided into Three Parts : The main Body of the Water will pass thro' the Middle Arch with the greatest Freedom, while the Side Currents pass in the same Manner thro' the Side Arches ; and when the Elbow of the River on the South Side is made straight, the 40 Feet Arch on that Side will be almost *as useful and as convenient* for the Navigation as the Middle Arch. ~~See~~ Mr. Wood in his Reply to the By-stander, Page 55, says thus : *From*

" From hence it is plain, that smaller
 " Arches will admit much more navigable
 " Water-ways than one large Arch, and at all
 " Times of the Tide, especially when we consi-
 " der how much the Acuteness of the Angle of
 " the Segment in the Single Arch renders use-
 " less the Chord, and consequently smaller
 " Arches will be more commodious in our Case."

Third Objection. The Angle this Arch makes with the Water is very acute at every State of the Tide, especially at High Water, and the Angle will at that Time be advanc'd into the very Middle of the River, therefore Ice, Timber, Vessels, &c. which the Swelling of the Water frequently bring down, cannot possibly avoid *breaking, chipping, and destroying* the ARCH from that Height down to the Bottom, besides the fatal Consequence that may happen to the NAVIGATION. *On the other Hand,* The Three Arches are guarded by their Cut-waters or Saliant Angles. And the Angle the Water makes with the North Arch on the same Level, in the Three Arches, is quite obtuse, and will fall 35 Feet from the Middle of the River towards the St. Nicholas Quay Wall.

Fourth Objection. The North Abutment projecting so far out as 74 Feet from St. Nicholas New Quay Wall into the River, and presenting

presenting a flat Surface of that Length against the rapid Flowing of a Spring Tide with a Westerly Wind, 'till that Length extends itself to 104 Feet, will be such a singular Circumstance, both as to the Bridge and the Navigation, as not to be paralleled in any Bridge in *Europe*, nay, I may venture to say in the *WORLD*.

Fifth Objection. The necessary *Purchases* to make the Ascents over this Single Arch Bridge equal to the Ascents of the Three (*Semicircular*) Arch Bridge on the Old Foundations will totally sink 10,861 *l.* * over and above the 12 Houses that yet remain unpurchased,

Height

* Even if you allow the single Arch to be so far crippled as to be only 8 Feet thick from the Underside of the Arch to the paving; and as there is only 6 Inches difference in ~~the height~~ between this single Arch and Mr. STRATFORD's three Arches on New Foundations, the Difference in the Purchases will be only trifling; but if you will see Mr. PHILLIPS's *Report*, you will find the Paving over the Three Arches on new Foundations, 30 Inches higher than the Paving over the Three Arches on the old Foundation, altho' the under Side of the center Arch in each Drawing is equal. This Difference will make a large Alteration in the Article of Purchases; which some *Gentlemen* cannot easily comprehend, being told by Mr. STRATFORD, that the Rise from the Paving of his single Arch Bridge is only 10 Feet 6 Inches higher than the Middle of *Tucker-street*; that his Ascents and Descents are only one Foot in Twenty; and that according to his Plan no more Purchases would be necessary†. Now I do aver, that his 10 Feet 6 Inches is a false Level, and so false as to account for the great Difference of Expende in the Article of Purchases. Therefore, I hope Mr. STRATFORD will, at the next Meeting, adjust and settle this capital Error.

† See Mr. PHILLIPS's *Report*.

purchased, to compleat the Ascent of One Foot in Twenty-three. I believe there are but few who will think One Foot in Twenty-three too easy a Pull against the Collar in the Centre of a large trading City; but if there should be many that think other^{wise} ~~ways~~, they will do well to elevate the Three Arches to 35 Feet. Such an *Elevation* will not only give 11 Feet Head Room on a Spring Tide, but greatly add to the Beauty of the *Super-structure*; whereas the Single Arch Bridge will only admit of 8 Feet Head Room, consequently the Water-way in the Three Arches will be greatly increased, while the Ascents to each Bridge will be equal with the same Purchases.

Thus, *Gentlemen*, I have obey'd your *Commands*, and have nothing more to add; but be assur'd that what I have said was with a Design to assist and inform your Judgment, and not with any Intention to offend those who may chance to be of a different *Opinion*.

The Qualification necessary to furnish you with these several *Observations* and *Remarks* in this *plain* and *artless* Manner, require neither *Wit* nor *Abilities* beyond common Sense and Understanding, but a right Application of them in the Choice of a *PLAN* may require more Knowledge and Experience than perhaps you think yourselves Ma-

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sters

sters of. I apprehend it was for this good and wise REASON you consulted the ingenious Mr. PHILLIPS, and I doubt not but a proper Regard will be paid to his superior SKILL.

I am, GENTLEMEN,

With the greatest Respect,

Your most obedient, and most oblig'd

Humble Servant,

BRISTOL, November
25, 1762.

JAMES BRIDGES.

P. S. I am sensible it will be urged, that I was formerly an Advocate for the Single Arch. I candidly own it, and I still continue to be so; but then it must have such an Height and Breadth as to answer the End proposed. Such an Arch I have drawn, which is void of every Objections, that of Expence excepted; and as I am always open to Conviction, and not bigotted even to my own Judgment, I should not be sorry to hear any Reasons that may convince me, at any Time, of being in the Wrong. I shall not be ashamed to confess it, as it will be only saying in other Words, *I am wiser to DAY than I was YESTERDAY.*

F I N I S.

